

WHAT IS CLAIMED:

1. An ultrasonic bi-plane imaging probe for invasive medical applications, said probe comprising:

at least one ultrasonic bi-plane transducer mounted at a distal part of the probe and comprising a piezoelectric member and a combination of a first sub-array of transducers disposed on a first surface of the piezoelectric member and a second sub-array of transducers disposed on a second surface of piezoelectric member, the first and second sub-arrays of transducers intersecting each other and being rotated by 90 degrees with respect to each other, the first and second sub-arrays of transducers being superimposed on the first and second surfaces of the piezoelectric member so as to form a unique transducer foot print; and

a transducer tip located at the distal part of the probe at which the bi-plane transducer is mounted.

2. An ultrasonic bi-plane imaging probe according to claim 1 wherein the probe further comprises a probe housing and a bendable coupler disposed at a junction between the probe housing and the transducer tip.

3. An ultrasonic bi-plane imaging probe according to claim 1 wherein the bi-plane transducer is of a curved shape.

4. An ultrasonic bi-plane imaging probe according to claim 3 wherein said curved shape is one of convex spherical, concave spherical, convex cylindrical, and concave cylindrical.

5. An ultrasonic bi-plane imaging probe according to claim 1 wherein the probe includes a longitudinal axis, the transducer has an acoustic propagation axis and the bi-plane transducer is mounted linearly with respect to the longitudinal axis of the probe such that one azimuthal axis of the bi-plane transducer is aligned with the longitudinal

axis and the acoustic propagation axis of the transducer is perpendicular to said longitudinal axis of the probe.

6. An ultrasonic bi-plane imaging probe according to claim 1 wherein the probe has a longitudinal axis and the bi-plane transducer is mounted on the probe at an angle between 30 and 60 degrees with respect to the longitudinal axis of the probe.

7. An ultrasonic bi-plane imaging probe according to claim 1 wherein said at least one bi-plane transducer comprises a first said bi-plane transducer and a second said bi-plane transducer mounted in the vicinity of the first said bi-plane transducer, and wherein the second bi-plane transducer is rotated with respect to the second bi-plane array transducer through an angle of between 30 and 60 degrees.

8. An ultrasonic bi-plane imaging probe according to claim 1 further comprising a conventional phased array transducer mounted on the probe in the vicinity of the bi-plane array transducer.

9. An ultrasonic bi-plane imaging probe according to claim 1 further comprising a biopsy needle guide for guiding insertion of a biopsy needle.

10. An ultrasonic bi-plane imaging probe according to claim 9 wherein the probe has a longitudinal axis, the first sub-array of transducers has a scanning plane aligned with the longitudinal axis of the probe and is used for imaging an organ of interest and the second sub-array of transducers is used for monitoring spatial positioning of the biopsy needle during use thereof.

11. An ultrasonic bi-plane combined imaging probe for medical invasive applications, said imaging probe comprising:

- a piezoelectric member;

- an ultrasonic bi-plane transducer comprising a combination of a first sub-array of transducers on a first surface of said piezoelectric member and a second sub-array of

transducers on a second surface of piezoelectric member, the first and the second sub-arrays of transducers intersecting each other and being rotated by 90 degrees with respect to each other, the first and second sub-arrays of transducers being superimposed on the first and second surfaces of the piezoelectric member so as to form a unique transducer footprint; and

a linear phased array transducer for transmitting high intensity ultrasonic energy to biologic tissue of interest, the linear phased array transducer being disposed on the probe in the vicinity of the bi-plane transducer;

the bi-plane and the linear phased array transducers being mounted such that the respective acoustic patterns produced thereby intersect at a predetermined distance from the surfaces of the bi-plane and linear phased array transducers.

12. A combined imaging probe according to claim 11 wherein the probe has a longitudinal axis, the bi-plane transducer has a surface and an acoustic propagation axis, and the bi-plane transducer is mounted with the acoustic propagation axis thereof perpendicular to the longitudinal axis of the probe and the linear phased array transducer forms an angle of less than 180 degrees with the surface of the bi-plane transducer, and the acoustic axis thereof intersects the acoustic axis of the bi-plane transducer at an predetermined distance from the surface of the bi-plane transducer.

13. A combined imaging probe according to claim 11 further comprising a biopsy needle guide disposed on the probe in the vicinity of the bi-plane and linear phased array transducers for guiding insertion of a biopsy needle in an area of intersection of the transducer acoustic patterns.

14. A combined imaging probe according to claim 11 wherein the probe has a longitudinal axis and the linear phased array transducer has a propagation axis, and is mounted with the acoustic propagation axis thereof oriented perpendicularly to the longitudinal axis of the probe, the bi-plane transducer being mounted so as to form an angle of less than 180 degrees with the surface of the linear phased array transducer.

- 15. An ultrasonic bi-plane imaging ultrasonic probe for use with an imaging system
- having an imaging system interface, said probe comprising: at least first and second
- sub-array transducers; and multiplexing circuitry for switching one or the other of the
first and second sub-array transducers to the imaging system interface.

16. An ultrasonic bi-plane imaging ultrasonic probe according to claim 15 wherein the multiplexing circuitry is software controlled by the imaging system.

17. An ultrasonic bi-plane imaging ultrasonic probe according to claim 15 wherein the probe includes a probe handle and wherein functions of said multiplexing circuitry are manually controlled by control means externally disposed on the probe handle.